VAMPIRE: Vulnerable Point Protection

Graham Peskett

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Police Scientific Development Branch
Home Office
Langhurst House
Langhurstwood Road
Horsham
West Sussex
RH12 4WX
United Kingdom

Tel: +44 1403 255451
Fax: +44 1403 213827
Email: gpeskett@langhurst.org.uk

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Abstract

With the increasing pressure on police manpower and resources, it is important that the correct response is made to each operational call-out. With respect to an alarm from a remote intruder detection system, this is of critical importance. A standard intrusion detection system offers no form of remote verification. Police officers must therefore be deployed in response to the alarm when there is a high probability that it is false. False alarms are a huge drain on police resources. Manufacturers have tried to assist the police by adding audio capabilities to the system. This offers only a small improvement, but with the price of closed circuit television cameras falling, video verification could be the way of the future.

This paper describes VAMPIRE, a Police Scientific Development Branch (PSDB) project which aims to develop a system capable of offering detection in the area surrounding a vulnerable point, combined with remote CCTV verification. At present, most portable detection systems do not have video verification of alarms and are thus not suitable for remote locations. However, by using tried and tested, commercial off-the-shelf technologies we aim to solve the problem in a new and cost effective way.

Such a system has a much wider customer market than remote monitoring of police operations. The armed forces have expensive military hardware that needs protecting. Presently, this guarding is performed by servicemen which again is an expensive use of resources. A VAMPIRE system, as described in this paper, could offer the detection and verification needed.

This paper details the methodology behind and the approach taken to develop a cost effective, vulnerable point, protection system.

Introduction

Policing is a manpower intensive operation and in today's economy where governments are expected to achieve the same quality of results or better with less resources, improving manpower efficiency can achieve a major saving on stretched budgets.

Responding to intruder alarms is only one example of the demands placed on the police service. Calls to alarms caused by weather, equipment malfunction or other non-human activity significantly outnumber calls to genuine intrusions and divert police resources. Staff costs are high so it is important to minimise the frequency of operational call-outs to false alarms. This is particularly important with respect to alarms from a remote detection system. Only 13% of intruder alarm calls received by the police in the UK during 1996 were genuine.

Police forces in the UK operate a 3 level response to an alarm from a remote monitored site. These are:

Level 1:	Immediate response;
Level 2:	Police response is desirable but attendance may be delayed, eg because of resource availability or higher priority calls; and
Level 3:	No police attendance, keyholder response only.

Initially, all systems are placed on level 1 status. If there are four false calls in 12 months of operation, the police response will move to level 2. Following seven false calls in 12 months level 3 will apply and police response will be withdrawn. The development of technology for reducing false calls by confirming activity within the alarmed premises is endorsed by the Association of Chief Police Officers (ACPO). This is because accurate verification of alarms can increase the effectiveness of the deployment of police officers.

Vulnerable Point Protection

Protecting the entire perimeter of a remote, unmanned site can be expensive. A high calibre fence, intruder detection system, CCTV and additional lighting may all be required to detect successfully and verify an intruder. Even for a small site, the cost of upgrading the existing equipment may be prohibitive. One possible solution is to protect only those objects or areas within the main perimeter that are vital to the operation of the site or are seen as likely targets. These areas are called vulnerable points (VPs). Typically, vulnerable points are moderately small objects or areas in the region of 10m x 20m in size and. It is the external limits of these objects that are protected.

A project was initiated to provide a cost effective solution to the problem of detecting on a short term basis and verifying intruders at VPs on remote unmanned locations. Working to an Operational Requirement (OR) agreed with the customer, PSDB commenced work in Spring 1995 on project VAMPIRE. VAMPIRE is an acronym for Vulnerable Area Methodology for Protection In Restricted Environments.

Initially, the VPs in mind were situated on large, industrial, utility company sites. Such targets included pipes and valves in the oil and gas industries and substations in the electricity industry. The aim was to offer short term detection in the area surrounding these VPs during a period of increased threat. A false alarm rate of 10 or so alarms per system per day was not seen as a major problem as long as the underlying cause of the alarms could be verified.

The requirement was for a system capable of being installed by the technical support units within 4 hours of arrival at site. The maximum time that the equipment was to be deployed on site was estimated at 5 days.

The equipment was to be situated within 3 metres of the VP. Alarm signalling was to be primarily by radio, over a range of 1/2 mile, probably along line of sight. Provision was to be made in the system to use other transmission media such as directly by cable to the response force or by sending the information down a telephone line. It was likely that the area surrounding the VP would be subject to a significant amount of electromagnetic radiation.

Each unit was to be housed in a discreet as possible a container. The system was to be capable of use with a loop framestore storage system. Multiply deployed systems were all to be monitored together at one location, at a maximum of 100 miles from the protected site. The cost of a complete system was not to exceed £3000.

VAMPIRE Solution - Discussion

The basic solution proposed for the system was to combine a number of detectors with CCTV cameras such that when an intrusion occurred at a zone the pictures from the camera observing the zone were transmitted to a remote location for verification.

Designing a new sensor would require a substantial amount of investment and would increase the timescales of the project. It was therefore decided to use commercial off-the-shelf technologies. One significant advantage of this approach is that all the individual components had been tried and tested and found to be reliable in operation.

Several types of detectors were considered and their merits and weaknesses evaluated. Passive infra red (PIR) sensors were chosen because of their efficient operation and high detection performance. The chosen PIR detectors had a corridor curtain detection pattern, operating over a range of 0-30m. This was achieved by using mirror optics to focus the infra red radiation onto the pyrosensor. Many other PIR designs were considered but most of them offered a volumetric detection pattern over a wide angle. The external detectors which were evaluated, operated over a much longer distance with the detection curtain starting after several metres. This initial region, ie from 0m to 30m from the detector is precisely the range in which we were looking to detect an intruder and therefore these sensors were deemed unsuitable.

Eight of the selected PIRs were linked in pairs to form a rectangular perimeter surrounding the vulnerable point. By using simple logic circuits, the two opposing detectors observing the same side of the rectangle were ANDed together such that an alarm needed to be signalled by both detectors simultaneously before a main alarm event was triggered. This created four separate zones. A time window could be included such that an alarm could be received from either sensor within a given period and a main event be signalled.

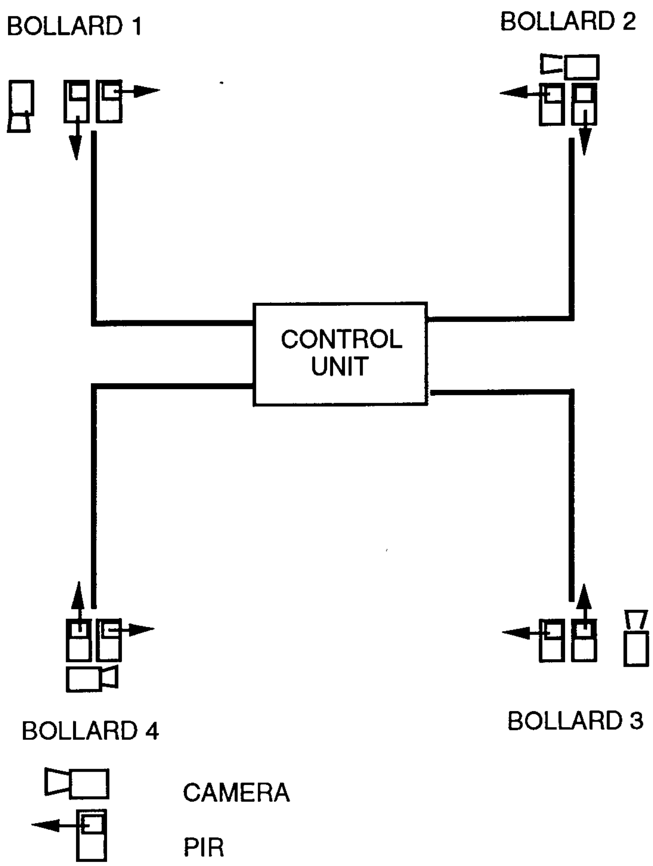

Figure 1: Schematic of the prototype VAMPIRE

A problem associated with PIR sensors is defining the exact range of the detector. By combining pairs of sensors in this way the zone length was tightly defined as being between the two sensors, even though each sensor could detect past its counterpart. This created a simple beam-break system, similar to a pair of active infra red detectors. The alignment of active infrared systems is, however, critical to achieve effective operation. With a passive based system the detection curtain is wider and therefore the alignment is less critical. This makes the system easier to deploy operationally.

Audio verification of alarms requires a well trained ear to establish whether the alarm is likely to be true or not. Visual verification can often achieve improved results.

Each pair of PIRs had a monochrome printed circuit board camera associated with it. The Operational Requirement did not call for broadcast quality, high resolution images. It would be sufficient to use cameras with adequate detail to enable an operator to determine whether an intruder was in the scene. Because of the short distances to be covered by the system, the cameras had short focal length lenses fitted. It followed that the target would occupy a large percentage of the TV monitor screen height, thus aiding the operator to determine the cause of the alarm.

When a main alarm event was detected, the camera observing the zone of the intrusion would be switched and the pictures associated with the alarm would be transmitted to a remote operator for verification.

The areas where the system was likely to be installed had sufficient ambient light levels for use with the cameras and additional illumination was not therefore required. Because of the relatively short lengths of the detection zones, infrared LED illumination has been considered as a possible solution, should additional lighting be required. Lighting of this nature means low power consumption, low heat emission and that the system is more covert than one which uses a white light source.

VAMPIRE -Prototype

A prototype system was constructed by mounting the sensors, together with the cameras, inside plastic tubing with a 130mm inner diameter, at a height of 1.35 m. The video switchgear and transmission equipment was housed in a separate unit. The construction cost for the prototype was approximately £3500.

The transmission of the alarm images was achieved by using a UK license exempt radio frequency transmitter. This system was capable of transmitting real time images over a distance of 750m line of sight. If the monitoring station was located further away then the pictures from the RF receiver unit could be fed into a remote telephone transmission system housed in a convenient building. The 750m distance was considered far enough to ensure that the necessary telephone connections would be accessible.

The prototype system was installed at our rough weather testing site to monitor the performance. The system was used for the protection of a zone equivalent to one side of length 25 metres of an area enclosing a vulnerable point. Each individual sensor was monitored, and by using statistical techniques it was possible establish a suitable time window for effective operation. The initial monitoring period of 3 months has shown a low average level of false alarms. Data analysis indicates that this figure could be as low as 1 false alarm per zone per day.

Customer Impressions

The PSDB prototype system has been demonstrated to many potential customers and has attracted a significant amount of interest. Although the prototype did not meet all potential customer needs, it would be possible to produce a system to meet other specific requirements. The sensor heads, with their combined detection and verification have attracted the most interest. Some suggestions for modifications have been incorporated in to the development system. However, it would be impractical to try and address the needs of all customers in one system.

By making the production units in a modular design, it may be possible to vary the number of detectors and cameras and the type of transmission system to fulfil particular requirements.

The technology developed in this project is not restricted to the protection of commercial vulnerable points. Other possible applications are to protect military hardware when deployed operationally, ie in UN peacekeeping detachments.

A pre-production system is currently under construction and will be installed at an operational site.

Future Technologies

Some police investigations require officers to mount a surveillance operation. A covert VAMPIRE system could be used to protect officers deployed in observation posts. The development of small sensor heads with remote transmission of both alarm and video, could provide aid in these situations. Such miniature sensor heads could be placed in suitable hides.

It may be possible to incorporate some basic form of video motion detection in the system to filter out false alarms. This would operate along similar lines to an AMETHYST system (1)

Other technologies are constantly being developed. Cameras with built in memory devices could be incorporated to allow the recording of pre- and post- alarm pictures. When played in sequence a loop of images so recorded could aid verification.

Conclusion

With the constant demand for a more efficient use of law enforcement resources and the price of CCTV cameras falling, the use of video verification of alarms is set to increase. VAMPIRE provides a possible solution for the protection of vulnerable points.

References

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